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TROPICAL HEALTH

THE CAMPAIGN AGAINST
TROPICAL DISEASE IN
BOTH HUMAN AND
PLANT LIFE.

BRITISH EMPIRE EXHIBITION, 1924.

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All exhibits are duly acknowledged.

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HUMAN DISEASE SECTION.

A NATION which boasts an Empire acknowledges a responsibility: the essence of empire is mutual benefit and common service. Ruskin has said "There is no wealth but life. That country is the richest which nourishes the greatest number of healthy and happy human beings."

The British Empire includes in its Dominions and Crown Colonies, more especially in the latter, many districts where climatic conditions foster disease, and in doing so hamper progress and limit productivity.

In the tropics health is the foundation of successful trade; a sick man is a poor organiser, a weak administrator, and a bad worker. Again and again in the history of commerce a promising enterprise has failed owing to disease. Malaria, yellow fever, sleeping sickness, plague and hookworm can all claim to have played a leading and dramatic part in the history of commerce, and too often they have gained the victory.

To bow to the inevitable is the role of mortal man, but tropical disease is not inevitable, it is preventable; moreover, it is preventable by measures within the reach of all who realise their importance.

The Tropical Health Section is intended to give a bird's eye view of the various diseases encountered, how they are caused, and by what means they can be prevented. It is essentially an exhibition for the layman, but no effort has been made to soften the picture; laymen must appreciate the problem in all its naked intensity, for from their ranks are drawn the great administrators who can control these gigantic issues.

Medical science has enabled man to drive the Panama Canal through a fever-stricken and uninhabitable area; it has removed from many centres of the tobacco industry all danger of the dreaded "yellow jack"; it has turned the "white man's grave" into a land of comparative safety. All over the world it is opening up fresh fields of commercial enterprise, but much still remains to be done, and medical science is powerless without the support of the enlightened layman. It is not sufficient for us to rest content in our own personal safety, though it is true that the well-informed European can sojourn in the tropics

with comparative impunity; we must adopt the broader view and stamp out disease for the vast native population within the Empire, which acts as reservoirs of infection.

The Tropical Health Section may be said to be divided into four parts.

A Jungle Scena has been devised to emphasize the material benefits to be derived from well-regulated preventive measures. Fifty years ago the pioneer was at the mercy of forces of which he had little knowledge and less control. Now he understands the danger, and can do much not only to avoid it, but even to render life agreeable under adverse conditions. The contrast is well shown in the two tableaux.

A Disease Section, which includes 27 diseases, constitutes the second part of this exhibit. One portion is devoted exclusively to the large group of diseases which are spread by biting insects. Each disease is epitomized in pictures, photographs, models and specimens, and is introduced by a short printed précis. There are also specimens and models of the various insects concerned. In this group are found such diseases as malaria, yellow fever and filariasis spread by mosquitoes; plague transmitted by the rat flea; relapsing fever transmitted by the louse; and three-day fever transmitted by the sand-fly.

Another group of diseases is essentially intestinal infections, and includes typhoid fever, cholera, dysentery, and various worm invasions.

Food deficiency diseases are represented by scurvy, beri-beri and pellagra, whilst considerable space is devoted to skin diseases, yaws and leprosy.

It is interesting to note that in the whole group of 27 diseases there is not one which cannot, to a very large extent, be prevented by wisely conceived and carefully executed hygienic measures. These are indicated in dealing with each disease separately and elaborated in the Hygiene Section.

Statistics are shown throughout the Section by means of a uniform illuminated device, which it is hoped will attract visitors to study this very important but somewhat unattractive aspect of disease.

TABLEAUX ILLUSTRATING THE CAMPAIGN AGAINST TROPICAL MALARIA.

The two life-like scenes briefly described below have been devised with the object of enabling visitors to the Tropical Health Section to carry away a vivid impression of the practical application of modern knowledge of the

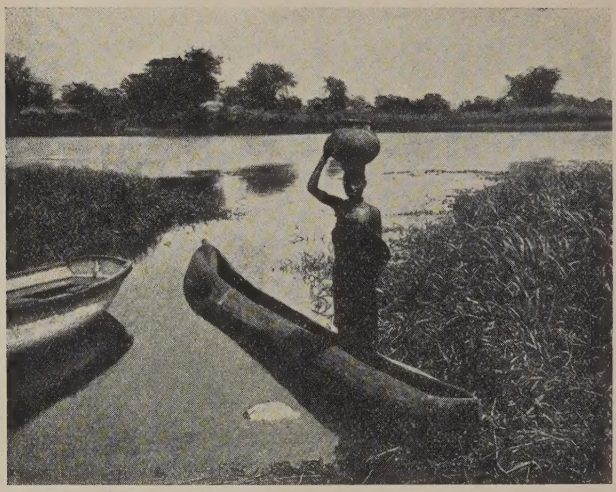
causes and prevention of tropical, insect-borne disease. Although in all such maladies (for instance, sleeping sickness, malaria, filariasis) no single measure is or can be completely effective, the line of attack most fruitful in results is that which is directed against the disease-carrying insect. While the procedure adopted to this end varies in detail according to the locality and the insect involved, the main principle—protection of the human population by reducing the numbers of the insect enemy and preventing it from breeding—is the same in all cases. In the present instance the disease selected for illustration is malignant malaria, and the locality is West Africa.

Scene I, on the spectator's left as he faces the entrance to the Tropical Health Section, represents an incident in the closing years of the nineteenth century, before the brilliant investigations of Sir Ronald Ross, based upon the epoch-making theory of the late Sir Patrick Manson, had demonstrated that malarial fever is conveyed from man to man exclusively by the bites of certain kinds of mosquitoes. An English explorer, mining engineer or agent of a trading firm, wasted well-nigh to a skeleton by repeated attacks of malaria, and attended only by a couple of faithful servants, lies at the point of death outside a wretched native hut in an opening in the tropical forest. Across the foreground meanders a sluggish stream, the breeding place of countless myriads of malaria-carrying mosquitoes, which, deriving infection from the inhabitants of the hut, will gorge themselves after sundown upon the ill-fated traveller, and would thus seal his doom in any event, even were he to outlast the day. Around the stricken man tropical nature riots undisturbed in heedless profusion, among which a group of brilliant butterflies at the water's edge serves but to heighten the pathos of the scene.

In Scene II, representing the identical or a closely similar spot at the present day, human effort, intelligently directed, has effected a marvellous transformation. Here as elsewhere the lessons taught by the pioneers of modern study of the causes and prevention of disease have been applied to such good purpose, that the sobriquet "The White Man's Grave," bestowed long since upon one of our oldest tropical possessions, has ceased to have any meaning. A wide clearing, affording space for cultivation, has been made in the jungle ; the former swampy stream, now confined between firm, sloping banks, and freed from all obstructing vegetation, is no longer a hot-bed of mosquitoes, which are, moreover, prevented from breeding by means of a film of oil mechanically applied to the water ; and the primitive "bee-hive" dwelling has been replaced by trim

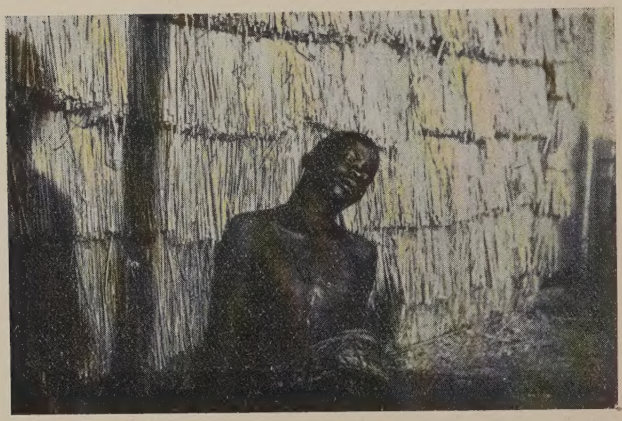
native huts of an improved, sanitary type, situated as far as possible from the white man's bungalow. The defences of the latter (including wire-gauze screens over doors and windows, and mosquito-proof beds) against such mosquitoes as may still contrive to exist in or penetrate into the locality will readily be noted ; and it will be observed that such is the confidence of the white resident in the combined results of the measures adopted that he is accompanied by his wife.

NOTE.—The Tropical Health Committee desires to make grateful acknowledgment to Dr. W. B. Johnson, West African Medical Service, of valuable assistance in the preparation of the tableaux exhibited.



MALARIA.—Breeding places of Anopheles funestus, River Shire, Nyasaland.

From Professor R. Newstead, F.R.S.



The last stage of Sleeping Sickness—Congo Free State.

From the Liverpool School of Tropical Medicine. Expedition to the Congo, 1902.

SLEEPING SICKNESS.

SLEEPING sickness is a disease which is confined to Tropical Africa. In certain districts it is widespread and very fatal, depopulating large areas of country and leading to misery and desolation.

It is caused by a minute animal parasite, known as a Trypanosome, which is conveyed from the sick to the healthy by the bite of a tse-tse fly in which it is capable of development. Many domestic and wild animals are also infected with trypanosomes, but it is still a matter of dispute as to how far these animals are responsible for the spread of the human disease. The parasites are found in the blood, spinal fluid and lymphatic glands.

The disease commences with a febrile attack and occasionally—especially in Europeans—a skin eruption may be seen. The glands become enlarged and eventually nervous symptoms supervene. The patient falls asleep even with food in his mouth, or in the full glare of a tropical sun. Maniacal outbursts may occur. As the disease develops there is complete indifference to surroundings and inability to perform any action, however trivial. Coma followed by death terminates this miserable existence. Concurrent affections are also liable to bring about the fatal issue.

Various arsenical preparations (atoxyl, &c.), "Bayer 205," and other drugs, have been used with success in treatment, but the late stages are very difficult to cure.

Prevention depends upon measures designed to exterminate tse-tse flies, and to safeguard human beings from their bites; whilst wholesale treatment with arsenical preparations has been tried. An effective method of stamping out this disease, however, has yet to be found.

Special attention is called to the photographs of natives suffering from sleeping sickness; these illustrate well the severity of the symptoms and show the main features of the disease—somnolence, emaciation, puffiness of the face, headache, &c. As has been stated above, this disease is transmitted by the bite of the tse-tse fly. The fly and its developmental stages are shown in wax models and specimens, whilst photographs depict its haunts and breeding grounds.

Great advances are being made with regard to prevention, as is shown in the illuminated devices. On the whole, however, it may be said that the question of prevention is extremely difficult, except under conditions of comparative isolation, such as were met with on the Island of Principe, where the disease was practically stamped out

by a well-organized campaign against the tse-tse fly. It is known that many species of big game carry trypanosomes closely resembling those which cause disease in man, and it has been suggested that these animals may act as " reservoirs " of infection ; on the other hand, it is possible that man is more liable to be infected in the absence of big game, as the tse-tse flies may be compelled to fall back upon human blood for food.

A point of special interest is the fact that the disease is limited to Tropical Africa, the distribution being determined by the tse-tse fly areas. Sleeping sickness must not be confused with the " sleepy sickness " which occurs in England.

2

MALARIA.

MALARIA is a disease of wide distribution, but of special importance in hot climates. It has played an important part in military and commercial history; in its grip empires have fallen, tribes have been exterminated, imperial progress has been impeded, and individual enterprise prevented.

It is caused by a minute animal parasite which invades the blood and is conveyed to man through the bite of certain mosquitoes (Anophelines). Malaria parasites multiply in the blood of man. If a suitable mosquito bites an infected man the parasites reach the mosquito's stomach, where they undergo a process of development, and about 10 days later the mosquito becomes capable of infecting a healthy man by its bite.

The disease has various manifestations, but there is generally fever characterised by three stages—shivering, extreme heat and sweating. Malaria is often difficult to recognise, as it may simulate other diseases, but the microscopic examination of the blood will reveal the parasite. Frequent attacks give rise to anæmia and enlarged spleen.

For treatment quinine is our most valuable remedy.

Prevention depends upon protection of the sick and healthy from mosquito bites, upon suitable measures to destroy mosquitoes and prevent them breeding, also upon the use of quinine, which keeps the blood free from the parasites so that mosquitoes can neither infect nor become infected.

The spread of malaria depends entirely upon mosquitoes of the genus Anopheles. It is therefore important to understand how they breed.

A central exhibit shows by means of models and actual specimens the stages of the process Eggs are laid on water only, and two further stages, namely, the larva and pupa, occur before the mosquito comes out. This happens in a week or more from the time of egg-laying. Models are also shown of the stages of the malaria parasite in the human body and also in the mosquito.

These models show, firstly, how the parasites multiply in the blood of man and become sufficiently numerous to cause fever, and secondly, how male and female parasites are formed in the blood. These sexual forms are those which develop in the mosquito, when the latter sucks a patient's blood; and it is in this way only that malaria is transmitted from a malaria patient to a healthy person, hence it is true to say, "No Anophelines, no malaria."

Special attention is directed to the various breeding places, e.g., streams, marshes, ponds, puddles, tree-trunks, or even domestic receptacles.

By the various methods of sanitation these breeding places can often be abolished or very materially diminished. The proper use of a mosquito net is the best means of personal prophylaxis. Whether the taking of quinine daily protects against infection is a disputed point. Various illuminated devices are shown to demonstrate the value of preventive measures.

BLACKWATER FEVER is a disease occurring in countries where a large proportion of the native population carry the malaria parasite in their blood and where the non-native population suffers from malaria more or less constantly. It affects almost entirely the non-indigenous population and, so far as is known, only occurs in those who are habitually suffering from attacks of malaria and who take insufficient quinine to prevent this state of things. If this view be correct, then we may state that if a person does not have malaria he will not develop blackwater fever. The immediate cause or causes of an attack are not fully understood, but there are good reasons for believing that a dose of quinine is one, if not the most important, of these causes, though there is no danger in taking sufficient quinine to prevent an attack of malaria ; indeed, evidence points to the conclusion that if this is done blackwater fever will not occur.

The disease is characterised by sudden blood destruction, amounting not uncommonly to half of the total amount, with the consequent hæmoglobinuria or blackwater, which gives the name to the disease.

There is no specific treatment for this condition but confinement to bed, good nursing, and measures directed towards flushing the kidneys are essential.

3

YELLOW FEVER.

AN acute and very fatal disease believed to be caused by a minute corkscrew-shaped parasite, known as the *Leptospira icteroides*. This disease in the past has been of great importance to ships trading with the West Indies, Central and South America ; it has also profoundly influenced the welfare of those working in many of the great centres of the tobacco and sugar industries.

The parasite is transmitted by the bite of a mosquito, *Stegomyia fasciata*, better known as the "tiger" mosquito. In many districts the disease has been eradicated by measures directed against this insect.

The chief manifestations are fever, hæmorrhages and vomiting—"black vomit" being characteristic. The skin has a yellow tinge, the eyes are blood-shot, whilst on various parts of the body violet patches, due to effusions of blood, may be seen.

No specific drug treatment is known, but good nursing and care with regard to diet are important.

To prevent the spread of infection patients must be screened from mosquitoes. Healthy people must use mosquito nets. The tiger mosquito and its breeding-places must be destroyed. Small fish have been used with excellent results for preventing these mosquitoes from breeding in water receptacles, as they prey on the larvæ.

A special vaccine is made and has been used as a safeguard against infection.

The "tiger mosquito," of which a model is shown, is entirely responsible for the spread of yellow fever, and it is this fact which has rendered possible the successful campaigns which have been carried out against the disease. The tiger mosquito, or Stegomyia, is essentially a domestic mosquito ; it breeds in water tubs, tins thrown on to rubbish heaps, and similar places. Such breeding-places (in contrast to ponds, streams, &c.) are readily controlled, and recently the Rockefeller Foundation has had great success in the use of small fish which eat up the larvæ. For most barrels one fish is sufficient, but it is necessary for regular inspection to be carried out to ensure success.

Many parts of the world, where yellow fever was at one time prevalent, are now entirely free from the disease. The recent campaign in Guayaquil is a good example, as can be seen from the illuminated device above the show case.

In olden times the disease was a great menace to sailors and was known under the familiar name of "yellow jack." It has occurred as sporadic outbreaks in the British Colonies on the West Coast of Africa, and is always a menace to newcomers in parts of the world where it occurs.

There is, perhaps, no better example of the value of scientific prevention than yellow fever.

4

DENGUE FEVER.

A NON-INFECTIOUS epidemic disease of which the organism has not yet been isolated, conveyed by mosquitoes (*Aëdes argenteus* and possibly *Culex fatigans*).

It occurs in Europe, Asia, Africa, America, and Australia, being, as a rule, confined to a belt between 40°N. and 40°S. It is a coast disease, except in India, and tends to recur at intervals.

The malady is rarely fatal but of grave economic importance owing to its wide range and high incidence. Bad epidemics cause complete disorganisation of trade.

Etiology.—The casual virus, not yet identified, is in the serum and corpuscles of the patient's blood, probably being present for a few days only.

It is conveyed by *Aedes argenteus* (*Stegomyia fasciata*, the "tiger" mosquito) which bites day and night, and abhors bright light, ventilation and draughts. It is most active as a carrier in hot weather and damp climates.

Dengue is conveyed from place to place by man and from person to person by the mosquito.

Trains and steamers transport infected persons and harbour the specific mosquito. Ships may take in water containing infected eggs, larvæ and pupæ of the mosquito.

Symptoms.—The onset is abrupt, with headache, aching eyes, pains in joints and body, loss of appetite, slow pulse. Temperature charts are variable but characteristic, showing three days' fever succeeded by re-elevation of temperature on the sixth or seventh day coinciding with the appearance of a rash resembling measles or scarlet fever. Blood shows a diminution of white cells. Convalescence is prolonged and depression is liable to occur.

Treatment.—The patient must be kept in bed for ten days under a mosquito net. A fluid diet is necessary. A hot bath, aspirin, Dover's powder or belladonna ointment may be used for the pains, whilst sleeplessness may be treated with sulphonal.

Prevention.—Institute measures for the reduction of mosquitoes. Use mosquito nets.

The causal agent for this disease has not been discovered, but the mode of transmission is known ; prevention therefore must be directed

against the insect vector. It must be emphasised that, though the disease is not a fatal one, it occurs in severe epidemics and causes widespread dislocation of commerce, as well as considerable personal suffering.

In certain parts of Australia dengue is very prevalent and much research work on this subject has been carried out by Australian scientists.

There are a great number of synonyms—"break-bone," "break-heart" and other fanciful terms, bearing witness to its most striking characteristics.

5

FILARIASIS.

FILARIASIS is a name applied to a group of diseases caused by certain white thread-like worms which invade the tissues of the body. *Filaria bancrofti*, the probable cause of elephantiasis; *Loa loa*, the cause of Calabar swellings; *Dracunculus medinensis*—the guinea worm—and certain others are included.

An interesting characteristic of this group is their need of an intermediate host for development and transmission. *Filaria bancrofti* is transmitted by a mosquito, *Loa loa* by a swamp fly (Chrysops), whilst the guinea worm develops in the body of a water cyclops, which becomes capable of infecting man when swallowed.

FILARIA BANCROFTI is a thin thread-like worm, three to three and a-half inches long. The adult males and females live in the lymphatics of the body and give birth to numerous embryos which can be seen in the blood, especially at night, with the aid of a microscope; these may be taken up by a mosquito. The embryos are, as far as we know, harmless but the adults damage and obstruct the lymphatics, giving rise to recurrent inflammatory attacks with fever. Constant repetition of these is the probable cause of elephantiasis.

Man is infected through certain species of mosquito in which the embryos undergo a process of development, ultimately reaching the proboscis for injection into the human host.

No drug treatment which is of any value has been discovered. Occasionally it is necessary to resort to surgery for removal of elephantoid masses of tissue causing serious inconvenience.

Prevention depends upon measures for destroying mosquitoes, reducing their breeding places and protecting the sick and healthy from their bites.

Special attention is directed to the specimen of elephantiasis of the leg, which shows exceptionally well the gross deformity resulting from this disease. Elephantiasis is an unsightly and crippling disease, and every effort should be made to reduce its incidence by well-regulated anti-mosquito measures.

As can be seen in the photographs, the disease affects old and young alike, and special efforts should be concentrated on prevention in view of the fact that no effective treatment is known.

LOA LOA is a short stout worm, confined as far as we know to West Africa. Males and females occur, and are

about $1\frac{3}{4}$ in. in length. They live in the connective tissue of man, and wander about the body, sometimes appearing just beneath the skin or beneath the surface of the eyeball. The commonest affection that they produce is known as Calabar swelling.

The embryos are found in the blood, more especially during the daytime, and are taken up by a fly (Chrysops), which acts as an intermediate host for development and transmission.

Calabar swellings are hot, red and tense ; they appear very suddenly, last three or four days, and then subside without any abscess formation.

No treatment is known.

A wax model is exhibited showing "Calabar swelling"—the skin lesion produced by this worm.

Loa loa is essentially migratory, and its effects are transitory. The worm, of which a specimen is shown, may invade the eye, where it forms a conspicuous and striking ob ect. In this situation it produces a certain degree of inflammation, but practically no permanent damage apart from unskilled attempts to extract the worm.

DRACUNCULUS MEDINENSIS (the "guinea worm"), a parasite of man.—The female worm is alone of importance. It varies in length from 13 in. to over a yard. It is white in colour, fairly stout, and commonly situated beneath the skin of the leg. After a time a blister appears over the head of the worm, this bursts, and a hole is seen through which a small portion of the worm protrudes. If the leg comes in contact with water a drop of milky fluid is expelled from the worm, which, under the microscope, exhibits many little embryos which swim freely in water. These are taken up by a cyclops—a minute crutacean allied to the water flea—in whose body they develop. Man is infected by swallowing a cyclops containing these embryos.

The usual treatment is careful and slow extraction of the worm ; if it is broken in the process, severe inflammation may be produced. It can also be killed by the injection of certain chemicals.

Prevention depends upon the safeguarding of water supplies from infection, avoidance of consumption of polluted water, or purification by boiling, filtration or chemicals.

Special interest attaches to the mode of infection of this worm. The female parasite wanders through the tissues of the body, seeking a part likely to come in contact with water. Here, as is shown in the model, she produces an ulcer, through which the anterior end of the worm can protrude, so that as opportunity offers the embryos may be discharged into water. Specimens of cyclops are also exhibited, as it is in a water flea of this genus that the embryos develop.

It has been stated that D. medinensis was the veritable fiery serpent of the Israelites.

6 RELAPSING FEVER.

THIS term embraces a group of closely allied diseases caused by corkscrew-like parasites found in the blood. Infection is conveyed from the diseased to the healthy by lice or ticks. Relapsing fever is especially common in times of war or famine, and has considerable imperial significance.

All the diseases in this group are characterised by a short fever with one or more relapses, apparent recovery being followed after some days by a return of fever and symptoms. Headache, pain in the limbs, nausea and vomiting are common ; the spleen and liver are enlarged, whilst bronchitis and nervous symptoms often occur.

Intravenous treatment with arsenical preparations, such as kharsivan, novarsenobillon and salvarsan, is effective, though at times African tick fever may not respond readily.

In louse-borne infections prevention depends upon measures directed against the insect. All patients must be freed from lice and clothing disinfected. Organized measures must be undertaken with regard to lousiness amongst the general population. For the tick-borne variety it is important to avoid native huts or encampments, whilst a mosquito net and night-light are of value.

The louse is responsible for the spread of typhus, relapsing fever and trench fever. Warmth is essential for its well being, and conditions which limit facilities for washing and encourage the continuous wearing of underclothing are especially favourable for its existence and spread.

During the Great War numerous investigations were made with regard to the best method of combating this pest, and elaborate arrangements for disinfecting on a large scale were made. Barrels, railway vans, and other improvised steam disinfectors, proved of the utmost value and played an important part in putting an end to the typhus and relapsing fever epidemic in Serbia. In the East African campaign tick-borne relapsing fever was of importance, and caused considerable sickness amongst the native personnel.

Special attention is called to the model of various spirochaetes showing those responsible for relapsing fever, syphilis or yaws, and yellow fever. These organisms, though similar in structure, are conveyed in various ways ; by contact—syphilis ; by mosquitos—yellow fever ; by lice—relapsing fever.

The gravity of this last disease is much reduced by the fact that in salvarsan, and similar arsenical preparations, we have a most rapid and efficient remedy.

7

PLAGUE.

PLAGUE is an acute specific disease caused by a bacillus—the *Bacillus pestis*—which attacks man and certain small animals. Infection is generally transmitted to man by the bite of some species of rat flea, though fleas from other mammals, such as the Californian ground squirrel, the marmot, the multimammate mouse, &c., have also been incriminated. In the pneumonic form of plague infection is conveyed directly from man to man in the sputum by what is known as droplet infection. Any conditions which encourage rats predispose to epidemics of plague.

This disease is not peculiar to the tropics, though especially common in certain parts of India, China and the Dutch East Indies. In the Middle Ages, Europe was devastated and England to a large extent depopulated. A rat epidemic generally occurs first, fleas from infected rats attacking man.

Three forms of plague have been described :—

(1) The bubonic, with a variable but high mortality. This variety is characterised by fever, enlarged glands and a tendency to sloughing and abscess formation.

(2) The septicæmic, in which an overwhelming invasion of the blood stream leads to rapid death.

(3) The pneumonic, which is said to be invariably fatal.

No effective treatment is known, good nursing is essential, serum therapy has been advocated and abscesses must be opened and suitably dressed.

Prevention resolves itself into isolation of the sick, an anti-rat and flea campaign, measures to safeguard ships and ports, and the use of prophylactic vaccine.

Special interest attaches to the important part played by certain rodents and other small mammals in the spread of this disease. The ubiquitous rat menaces ports in every part of the world, and constant vigilance is exercised by health authorities to exclude this disease. In India intensive anti-rat work is carried out, as shown in the series of paintings after Turner. In California the ground-squirrel is incriminated, in Manchuria, the marmot, whilst in South Africa many small mammals have been shown to carry plague. These animals may be regarded as reservoirs of infection ; the actual transmission depending upon ecto-parasites, notably fleas. Specimens

and models are shown illustrating this aspect of the disease, also some of the measures adopted to control the spread of infection.

Photographs and paintings of plague patients are exhibited, and pathological specimens illustrating three varieties of the disease.

Attention is directed to certain exhibits of considerable historical interest. The black death affected Europe in the 11th century, increased in severity up to the 14th century, and then declined so that, so far as England was concerned, it practically vanished after a final outburst in the 17th century. Two of the leaden crosses, which were buried with plague corpses, are shown. The costume worn by physicians attending plague patients, and certain instruments used for opening the bubos and other purposes are included amongst the exhibits; whilst special interest attaches to the details of the ancient pictures dealing with plague, of which some reproductions are shown.

8 PHLEBOTOMUS FEVER.

"PHLEBOTOMUS" or "Sandfly fever" is an acute specific fever, common in tropical and sub-tropical countries, caused by a virus, possibly a leptospira, conveyed to man by the bite of a small midge, called Phlebotomus or the Sandfly. Incubation period is about five days. The disease is characterised by three days' fever, flushed face, suffused eyes, rheumatic-like pains in back and legs, and severe frontal headache. There is no mortality but convalescence is often prolonged and accompanied by considerable nervous depression. The seriousness of the disease lies in the fact that whole communities may be affected at the same time. These epidemics delay trade, and are a source of danger to forces guarding various outposts of the Empire, especially as the natives in these regions are more or less immune to the disease.

The virus of the disease is handed on from generation to generation of Phlebotomus in its breeding grounds, by means of the grub feeding on the dejecta or dead remains of the parent flies.

Preventive measures against this fever must be directed against the fly. It is necessary to eliminate its hiding and breeding places. Cracks in the ground or in masonry must be got rid of by levelling, pointing, &c. Premises must be thoroughly cleansed and dust and cobwebs removed. Good refuse disposal is essential. The sandfly must be kept away by sandfly-proof nets, electric fans or repellents, such as paraffin or camphor, whilst insects living in corners must be destroyed by swatting or spraying with cresol.

Special attention is called to the original paintings showing the development of the Sandfly.

To prevent an insect-borne disease, it is necessary to understand the exact mode of development of the transmitting insect, and to know its breeding places. In this Section it is possible to get an idea of the detailed work required to carry out such an investigation, more especially in the case of an insect so small as scarcely to be visible to the naked eye.

9

ROCKY MOUNTAIN FEVER.

DEFINITION.—A specific fever very like typhus caused by the bite of a tick, and limited to the Western United States.

Cause.—Ricketts, Wolbach and others have shown that the disease is caused by minute dot-shaped organisms found chiefly in the lining cells of the blood-vessels of man and infected animals, also in the salivary glands and eggs of the wood tick, *Dermacentor venustus*, which transmits the disease.

In the endemic area these ticks are found on various domestic and wild animals, especially ground squirrels, woodchucks and chipmunks.

Symptoms.—Chills occur and high fever, lasting about fourteen days, with delirium and great prostration. A dark-coloured eruption appears about the fourth to the seventh day, giving the body a speckled appearance; this slowly passes and is followed by desquamation.

Mortality.—Varies from 90 per cent. in Montana to 5 per cent. in Idaho.

An attack confers immunity.

Prevention.—Workers must be protected from the bites of ticks. Destruction of ground squirrels and other infected animals is important, whilst domestic stock are systematically dipped to prevent the spread of, and, if possible, to exterminate the ticks, the adult form alone of which attacks man.

Treatment.—A specific serum has been prepared by Noguchi, which has given some satisfactory results.

Special attention is called to the tick which carries this disease, and to the animals which act as reservoirs of infection. Though not a disease of tropical climates, it is closely linked with the other "insect-borne" diseases in this Section of the exhibit owing to its mode of transmission; moreover, the investigations of Wolbach and Parker have a direct bearing upon other diseases, more common in the tropics, and stimulate further research with regard to tick-borne disease.

10

LEISHMANIASIS

("Oriental Sore" and Kala-azar.)

LEISHMANIASIS is due to either general or localised infection of man by microscopic animal parasites of the genus Leishmania.

The infection may involve either limited areas of the skin causing "oriental Sore," also known locally as "Aleppo button," "Bagdad boil," &c.—a common and non-fatal malady in many tropical countries—or may invade the tissues of the body generally causing kala-azar, a chronic and fatal disease. The characteristic symptoms of this severe variety of leishmaniasis are prolonged irregular fever, enlargement of the spleen and emaciation.

A definite cure in the form of intravenous injections of salts of antimony has recently been discovered for this hitherto incurable infection.

Oriental sore persists for some time, but eventually gets well. Antimony and various local measures may shorten its course.

The method of spread of leishmaniasis is still the subject of investigation. In the present state of our knowledge prevention is based on the isolation and cure of infected cases, and on the destruction of native dwelling-places in which the disease is endemic.

It is important to distinguish the non-fatal local disease—oriental sore—and the very fatal kala azar, which means black fever, and is so-named from the appearance of its victims. In 1900 Sir William Leishman discovered the parasites in films taken after death from the spleen of a soldier who died in Netley from fever contracted at Dum-Dum. In 1903 Donovan observed the same parasites in blood obtained by splenic puncture performed during life.

As can be seen from the illuminated statistical scheme kala-azar is a disease which before the introduction of treatment by the intravenous injection of antimony was almost invariably fatal; since the introduction of this treatment the position is much more hopeful. The problem is truly imperial, as parts of the Indian Empire are very heavily infected. Napier states that of the 46 million population of Bengal from 1,500,000 to 2,500,000 are infected. It is important to remember that in spite of the wide prevalence and extensive research on the subject, the exact method of dissemination is still unknown. The causative organism is known, the treatment is known, but the mode of transmission, upon which rational prevention must mainly depend, is still to be found.

11 TROPICAL SPLENOMEGALY

A CONVENIENT name for a group of unclassified diseases of non-malarial and non-parasitic origin, characterised by considerable, and more or less permanent, enlargement of the spleen of which the cause is unknown.

The group includes Egyptian splenomegaly and Banti's disease (splenic anaemia), and probably embraces several diseases occurring in Egypt, Arabia and elsewhere, chiefly in young adult life.

Symptoms.—Great and progressive enlargement of the spleen is typical. The liver is also enlarged, but later shrinks, causing dropsy.

The disease is of long duration with anaemia, increasing weakness, digestive disturbances, abdominal pain, and at times elevation of temperature.

The blood count shows a diminution of red and white blood cells, especially of the latter. The red cells show loss of colouring matter.

As the spleen increases and the liver shrinks, anaemia, emaciation and dropsy progress. A fatal termination is brought about by exhaustion, by internal haemorrhage, or by intercurrent disease, such as pneumonia.

Treatment.—Early removal of the spleen (splenectomy) before dropsy appears is the only treatment holding any hope of cure.

Preventive measures must be directed against infective conditions of every kind.

Amongst other causes of splenomegaly must be included abscess of the spleen and haemorrhage into its tissues.

Very little in the way of medicinal treatment can be done in this group of diseases until further research, with regard to causation, has been carried out. It cannot be too strongly emphasised that treatment and prevention are very largely dependent upon an accurate knowledge of the causative agent and mode of transmission. Enlarged spleen has, in many instances, been traced to its definite origin, as in malaria and Kala-azar, and it is certain that as knowledge increases so this group of diseases will become appreciably smaller.

12

TRACHOMA.

A CONTAGIOUS inflammation of eyelids, with purulent discharge, roughening of conjunctiva, and formation of granules, frequently ending in permanent damage to sight and often total blindness.

Prevalent in Egypt, Palestine, Arabia, India, Central Asia, China, Japan, East Indies ; it occurs also in Australia, America and Europe (chiefly Eastern Europe). In England it occurs, especially in the Eastern Counties among foreigners.

Negroes are practically exempt.

Epidemics occur with overcrowding under unhygienic conditions, viz., in emigrant ships, barracks, institutions.

Infection is transferred mechanically by contact—fingers, sponges, handkerchiefs, towels, etc. Flies carry the virus ; dust and smoke aggravate the condition.

Cause.—No specific organism is known, but various bacteria are associated with the disease, more especially those which form pus.

Symptomatology.—The eyes are painful or uncomfortable and do not tolerate bright light. Lachrymation is a conspicuous feature. The swollen eyelids adhere and secrete pus. On everting the lids the velvety mucous membrane appears studded with coarse raspberry-like granules, which later become sago-like. Scar tissue is formed, whilst adhesions, distortions of eyelashes and eyelids, contractions, opaque cornea, and other grave results up to total blindness may occur.

Treatment.—Local applications and operative measures are required for this intractable condition.

Prevention.—Importance attaches to personal cleanliness, nourishing food, sanitary measures against overcrowding, and separate washing arrangements. The eyes may be cleansed with weak warm antiseptic lotions. Routine instillation of zinc sulphate drops is of value when the disease appears where men are congregated. Notification is most important.

In countries where immigration is strictly controlled, trachoma is rigorously excluded. The comparative rarity of the disease in the British Isles is a good testimony to the efficiency of our Alien Acts.

It is not generally realised how prevalent this disease is in China ; in parts of Northern China as high a proportion as 50 per cent. of the population may be affected. It is stated that this is due to the use in common of various toilet requisites, more especially of hot towels, also to the neglect of medical examination of teachers and others brought into close association with children.

Special attention is directed to the excellent series of paintings of this disease, which emphasise the gravity of the infection and fully justify the elaborate efforts being made for its control.

13

DYSENTERY.

DYSENTERY is a name loosely applied to many bowel diseases which occur in tropical and sub-tropical countries. It is characterised by inflammation and ulceration of the lower bowel, accompanied by diarrhoea, pain and the passage of blood-stained mucus. It was common amongst troops serving in the East during the Great War and is always a danger in hot countries, more especially where coolies are crowded together under insanitary conditions.

Dysentery may be caused by animal or vegetable parasites which gain access to the body through contaminated food or water. Food contamination chiefly takes place through human agency, flies or dust. Chill and any condition lowering the general health is a predisposing cause.

A special form of liver abscess results from amoebic dysentery.

For amoebic dysentery treatment with emetine is most effective, whilst bacillary dysentery is treated with aperient salines and serum. Nursing and suitable diet are important.

The spread of infection may be prevented by care with regard to water supplies, sterilisation of water, protection of food from contamination, destruction of flies and control of fly breeding.

Irritation to the digestive tract by unsuitable food, strong purgatives or chill must be avoided.

Residents in tropical and sub-tro ical climates have always been familiar with this group of diseases. During the Great War convalescents returned to England, many inevitably carrying the organism of amoebic dysentery, and investigation showed that this parasite was far more common in this country than had originally been supposed. Intestinal diseases, however, do not readily spread under the hygienic conditions of our land ; indeed, a modern water-carriage system of sewage disposal is the surest preventive against diseases of this nature, the three main agents of infection—hands, flies and dust—being to a large extent eliminated. As with all such diseases, dysentery is mainly a danger under the unnatural conditions incidental to warfare.

Bacillary dysentery was prevalent on the Western front during the Great War, whilst it has always been liable to occur in lunatic asylums and other crowded institutions.

A satisfactory preventive vaccine for bacillary dysentery has not yet been manufactured, whilst for amoebic dysentery the nature of the infective agent precludes such a method of attack.

Special attention is called to the pathological specimens showing liver abscess resulting from amoebic dysentery. This grave sequel to the disease is also amenable to emetine, as is well shown in the illuminated statistical schemes, to which attention is invited.

14

TYPHOID AND PARATYPHOID FEVERS.

TYPHOID and PARATYPHOID FEVERS are acute, communicable infections caused by several closely related specific bacilli. These diseases, primarily blood infections, later involve the intestinal tract, leading to ulceration and sometimes hæmorrhage and perforation.

The diseases are world-wide in their distribution, more especially affecting areas where sanitation is defective.

Infection occurs through the ingestion of food or liquid contaminated with the specific bacilli which originate from " carriers " and reach the food either directly or by indirect means such as flies.

The infection is typically characterised by continuous fever, rose rash, slow pulse and abdominal symptoms.

Prevention of the disease is effected by protection of food and water from direct or indirect bacillary infection. Individual protection can be attained by the use of prophylactic inoculation.

Special attention is directed to the striking reduction in incidence of these diseases owing to preventive inoculation combined with organized sanitary measures. This is especially well shown in the illuminated statistical device contrasting the Great War with the South African campaign. The Enteric group of diseases is, and always must be, the great menace to armies under active service conditions, but preventive inoculation has done much to reduce the danger. The exhibit showing the method of preparation of the vaccine is therefore of special interest, and shows the meticulous care which is taken to guarantee purity and accurate dosage. The problem of apparently healthy people who carry the infective organism in the gall bladder or in the bowel has complicated the preventive scheme ; it is known that such "carriers," who may or may not at some time have had a definite attack, can cause epidemics by handling food supplies or otherwise.

The possible risks attaching to shell-fish, "fattened" in polluted waters, or of uncooked vegetables—such as watercress -contaminated by sewage, are called attention to by sundry exhibits.

At one time in England " typhoid fever " was a regular source of income to the general practitioner ; now it is an item not worth considering. This is due to the great advances made in Public Health work and administration ; inoculation widens the preventive scope and offers hope even under less favourable conditions.

15

CHOLERA.

CHOLERA is a severe intestinal disease characterised by violent purging, vomiting, cramps, extreme collapse, and a very high mortality. The disease is rapid in its spread, dramatic in its severity, and disastrous in its results upon commercial enterprise.

It is caused by an organism known as the "comma bacillus," which is swallowed with contaminated food or water. The bacillus quickly multiplies in the intestine, so that the dejecta contain myriads.

The onset of the disease is sudden, the patient suffering from vomiting, diarrhœa and agonizing cramps. Death may occur in from 10 to 30 hours from onset.

Treatment must be rapid and thorough. Repeated injections into the veins of large quantities of salt solution are of the utmost value (Rogers). Drugs are of little use, but pot. permang. and certain essential oils have been advocated, also kaolin in large doses.

Prevention depends upon a good water supply, water purification, avoidance of uncooked vegetables and fruit, protection of food from flies and dust, and general rules with regard to the disposal of excreta, &c. Inoculation is a powerful but transitory preventive. It is important to avoid chill, strong purgatives, and the consumption of unripe or over-ripe fruit. All cases must be isolated.

There is no disease which presents more dramatic features than cholera; it strikes a community with a suddenness and severity which has practically no parallel in medicine. In the earlier stages of an epidemic the disease is especially fatal, and frequently a few hours will cover the whole course of the disease from onset to death.

As shown in the illuminated statistical devices the mortality has been appreciably lowered by Rogers' saline treatment, whilst preventive inoculation can do much to reduce the incidence.

In Western countries, where up-to-date sanitary measures are practised, cholera is extremely rare. In India it is common and is liable to be spread widely by pilgrimages, fairs and commerce.

Special attention is drawn to the series of paintings illustrating causation. Epidemics have been brought about by contaminated water, infected milk, mulberries which have fallen into polluted water, cracked melons over which infected flies have crawled, and in many other ways.

A pure water supply is of special value in preventing cholera, and examples of effective and portable filters are shown.

The acid gastric juice is very destructive to the cholera vibrio; a healthy gastric state therefore offers a first line of resistance against invasion by this organism, whilst fear, chill and other conditions productive of impaired gastric secretion, predispose to the disease.

Many compact outfits for treatment with hypertonic saline are on the market; the specimen shown provides a good example of the apparatus required.

16

ANCYLOSTOMIASIS.

ANCYLOSTOMIASIS or "hookworm disease" influences profoundly the labour conditions and commercial prosperity of many parts of the British Empire.

It is common in the tropics and occurs in deep mines in temperate climates.

The disease is caused by invasion of the intestines by small white worms, about half an inch long, which attach themselves to the walls, extract blood, and produce poisonous substances. The eggs of the worm pass out of the body and under suitable conditions of heat and moisture develop in the soil. The larvæ pass in through the skin of people working on contaminated soil and after a complicated passage through the body eventually reach the intestines.

People who are heavily infested with these worms become pale, weak and apathetic; they work badly. A very heavy infection may be fatal.

The disease can be cured by various drugs which destroy the worms—thymol, betanaphthol, oil of chenopodium and carbon tetrachloride.

Prevention is very important. Good arrangements for disposing of excrement are essential. Education of the local inhabitants is most important, whilst the Rockefeller Foundation has also laid stress upon the value of wholesale treatment.

Special attention is directed to the wide distribution of hookworm disease and its serious effect upon the quality and quantity of work produced by those affected. Suitable preventive measures can do much to reduce the incidence and severity of the disease, as is shown by the results achieved by the Rockefeller Foundation in its world-wide campaign. In many deep mines where ancylostomiasis has been prevalent in the past it has been stamped out by suitable sanitary precautions. The severity of the disease is proportional to the number of worms invading the intestines, a matter which can be controlled by measures which limit soil contamination.

Preventive treatment is specially advocated in this disease and, when combined with education, much can be accomplished.

The method of attachment of the worms to the intestines is illustrated and the large wax models show the head end of the two species mainly responsible for this disease. Attention is directed to the hooks by means of which the worms fix themselves to the walls of the gut. The mode of infection is of special interest: the eggs pass out of the body with the excreta and develop into larvæ in the soil. If brought into contact with human skin these pass in through a hair follicle, invade the blood-vessels, pass to the heart, thence to the lungs, up the trachea, down the œsophagus, and into the intestine, where they reach full development.

Until recently thymol and oil of chenopodium were the drugs most used for treatment; these are now replaced to a large extent by carbon tetrachloride, which is a most valuable remedy.

17

SCHISTOSOMIASIS
⟨Bilharziosis⟩.

A DISEASE caused by a small fluke-like worm which in larval form penetrates the skin and reaches the liver by the blood-vessels. When fully grown it descends via the portal veins to deposit eggs in the bladder or bowels. These pass out in the excreta and hatch in water into an embryo which must invade some appropriate water snail for further development. In this way, within a month, larvæ (cercariæ) are produced which invade the skin of persons in contact with infected water.

Three species of worm are responsible—*Schistosoma mansoni*, *S. hæmatobium*, and *S. japonicum*—with a wide distribution from the West Indies (S. mansoni) to the Far East (*S. japonicum*), whilst the first two species are both found in Africa, where they probably originated. *S. hæmatobium* occurs in Portugal and has been reported from India, Australia and England. In Egypt 6,000,000 out of 13,000,000 inhabitants are infected, whilst in parts of China 50 per cent. to 90 per cent. suffer.

The disease produces anæmia, weakness, wasting, bloody and painful micturition, diarrhœa with blood, enlargement of liver and spleen, and dropsy.

Treatment by intravenous injections of antimony tartrate kills the parasites.

Prevention depends upon treatment of patients, guarding against the pollution of water which harbours the snail hosts, exterminating these hosts, avoidance of infected water for bathing or any other purpose, and purification of all domestic supplies by boiling, storage for 36 hours or treatment with sodium sulphate.

This disease in view of its prevalence deserves more recognition from the public than it obtains. It is a serious disorder with severe sequelæ ; it follows a prolonged course, and until the introduction of treatment by the intravenous injection of antimony tartrate was practically incurable. Its wide prevalence and heavy incidence are emphasised above and call for drastic preventive measures, which can only be instituted when the Authorities in countries where it prevails realise its importance and the precautions necessary to stamp it out. General preventive measures and curative hospital treatment should be instituted in all infected countries, whilst newcomers should be warned of the danger.

The causal worm was discovered by Bilharz in Cairo in 1851, but the complete life-story has only recently been worked out. Whilst the spread of this disease is limited by the distribution of the intermediary snail hosts, there are indications that the parasite has powers of adaptability both as regards climate and choice of host.

Special attention is directed to the problem of this disease as it affects Egypt and South Africa, whilst much interesting recent work has been carried out in China with regard to the disease caused by the *Schistosoma japonicum*. The severe form of disease produced in this part of the world is well illustrated in some of the photographs shown in this Section.

The recent discovery of Bilharzia in Portugal is of special interest, and attention is directed to the photographs dealing with this subject.

18

SCURVY.

THIS disease used to be the great scourge afloat, and was dependent on the want of fresh provisions during long voyages; it also occurred in Arctic and Antarctic expeditions. It was eliminated in the Navy by the introduction of lemon juice on the advice of Dr. Lind. The substitution of lime juice for lemon juice at a later date proved much less effective. In the Army scurvy was found under conditions of fresh food shortage during the Great War in Mesopotamia, etc. In the Rand mines a modified form of scurvy is common.

The cause is a deficiency in the diet of a factor easily destroyed by heat and oxidation, known as vitamin C; this is most abundantly present in fresh fruit and vegetables, cabbage, swedes, tomatoes, potatoes, onions, peas and beans, and to a less extent in meat and milk.

The symptoms are debility, pallor, hæmorrhage, from the gums and into the skin, muscles and membranes, accompanied by stiff joints and pain. It is generally three to four months before symptoms occur, as the reserve vitamin of the body is first used up.

In treatment, orange and lemon juice, and other anti-scorbutic substances, given by the mouth or, in bad cases, intravenously are required. In the absence of fresh vegetables germinating peas are effective; orange juice should be used for babies.

For prevention it is necessary to provide food which contains vitamin C, making certain that it is not destroyed by over-cooking, and that it is eaten. Tinned tomatoes are anti-scorbutic.

This disease may occur either in hot or cold climates. It affected the Indian troops in Mesopotamia, it has affected explorers in the Arctic regions. Its prevention is purely a question of diet. Samples or models of various foodstuffs which will prevent this disease are shown.

The history of scurvy is especially linked with the Navy; indeed, for many years it was the scourge of the Service. Owing to the researches of great naval surgeons, the prevention of this disease was placed on a firm basis.

19

BERIBERI.

BERIBERI is a disease due in all probability to a deficiency in the diet of some substance (? vitamine) necessary to the welfare of the individual. The disease is found in most tropical and subtropical countries, and may occur in epidemic form among gangs of labourers, in jails, or on board ship. An exclusive diet of polished rice is especially liable to produce this condition.

The disease is characterised by wasting muscles, inability to walk, serious heart complications, and in some instances is associated with marked dropsy. Frequently death ensues, and, in any case, recovery is very slow and prolonged.

It is a very important factor in all commercial enterprises employing a large native labour force.

In treatment drugs do not appear to exert any beneficial influence on the course of the disease. Good nursing and careful attention to diet are the essentials. Beans, peas, lentils, oatmeal, yeast, eggs, fresh meat and milk contain an abundance of the required vitamines, which are also present in certain fresh vegetables, such as onions and tomatoes.

Prevention depends upon a well-balanced and varied dietary, the isolation of the sick from the healthy, and improvement in general hygienic conditions.

This disease depends for its importance very largely upon the fact that in many parts of the world rice is the staple food of the population. As can be seen in the illustration, the rice grain consists of a central mass of starch surrounded by an envelope of somewhat different structure. When rice is milled, this outer envelope is removed and forms part of the rice polishings. People whose sole article of diet is unmilled rice, do not suffer from beriberi ; on the other hand, people who consume an exclusive diet of well-milled and polished rice may develop the disease.

The vital food factor, which resides in the outer layers of the rice-grain, has been classed as a vitamine. Its importance is clearly proved by a consideration of the fact that beriberi can be cured or prevented by the administration of tiki-tiki, which is a product manufactured from rice polishings. A sample of tiki-tiki is shown, also an enlarged photograph of the factory where it is made.

Special attention is directed to the specimen of dilated heart, which is so characteristic of severe beriberi, and constitutes one of the chief dangers of an attack.

Ship beriberi is a common disease, and its exact causation has been the source of much discussion. A sample of the diet consumed by a ship's crew which suffered from an epidemic of this disease is shown.

The whole question of diseases caused by diet deficiency is a very difficult one, and it is probable that further research will reveal other factors of importance in their causation.

20 PELLAGRA.

A CHRONIC disease, of wide distribution, affecting mostly the poor and those employed in agricultural work; common in women and children, but found at all ages and in both sexes. Though thought by many to be associated with the consumption of maize, such association has not been definitely proved. It may possibly be due to (1) a "toxin" from diseased grain; (2) infection introduced with the food; (3) a deficiency of some special factor in the food. As regards the last named the disease may be due to protein deficiency—i.e. the absence from the diet of some substance essential for nutrition. The disease is rare in this country.

It generally commences in the spring or early summer, and recurs from year to year. The chief symptoms are (1) gastro-intestinal; (2) an eruption, mostly on exposed parts—face, neck, hands, arms and feet—symmetrical and having the appearance of severe sunburn followed by desquamation of the skin; (3) nerve symptoms which may end in dementia. It is most often mistaken for other skin diseases, sprue or typhoid fever. The mortality is about 3 per cent. in Italy, 10 per cent. in the United States of America, and is considerable in some of the British West Indies and other British colonies.

For treatment remove cases from endemic area; the maintenance of good nutrition and avoidance of debilitating conditions and diseases are necessary. Plenty of fresh milk, eggs, meat, beans, peas are required. When mental symptoms are marked little can be done beyond asylum treatment.

For prevention a well-regulated diet is essential.

A point of special interest is the effect of light upon the occurrence and distribution of the eruption. The time of the year at which relapses occur is significant also the effect of clothing upon the distribution of the rash which is shown in certain of the illustrations. Pellagra is a disease which is more generally distributed than was originally supposed, and special attention is called to its occurrence in England, where, as can be seen from the paintings, cases may be found in the lunatic asylums, also in America, where it is very prevalent.

21

YAWS.

YAWS is a chronic, contagious disease somewhat resembling syphilis, but not venereal in origin, widely distributed among natives of tropical countries, and causing much sickness amongst those sections of the population from which native labour is drawn.

The disease is caused by a corkscrew-like micro-organism (*Spironema pertenue*), which gains access to the body through any skin abrasion, either by direct contact with a yaws patient or by means of contaminated flies or other insects.

It is characterised in the early stages by rashes and the eruption on the skin of raspberry-like masses, and in the later stages by bone disease and deep ulceration often resulting in gross deformity.

For treatment salvarsan (" 606 ") and similar preparations of arsenic are effective, and bring about an almost miraculous disappearance of symptoms and rapid cure in early cases.

To prevent the spread of this disease effective treatment and dressing of sores together with a strict observance of the general rules of personal hygiene are indicated.

As can be seen from the map of distribution, yaws is widely scattered throughout the tropical regions of the world. In certain territories the incidence is very heavy ; indeed, it may be said that a large proportion of the native population contracts the disease. The skin lesions are unsightly, and very persistent, but it is the later manifestations, clearly shown in many of the photographs, that demonstrate to us the serious effect such a disease must have upon the labour market. In many of our Colonies yaws is prevalent, and special attention is called to the photographs which show that the disease is readily curable in its early stages. The treatment is simple and takes very little time ; it is sure in its results, and not only cures the patient, but also abolishes a potential source of infection. Widespread treatment in a disease of this sort must do much to reduce its incidence or even abolish it altogether, and in yaws —which may be classed as a contact disease —the most direct method of attack is that which deals with the actual source of infection, namely, the sick person. The organism which causes the disease is structurally very like that of syhpilis, and, indeed, there is so close a resemblance between the two diseases that the question of their identity has been discussed. The general opinion, however, is that the diseases are quite distinct, and, in any case, yaws cannot be regarded as a venereal disease.

22 TROPICAL SKIN DISEASES.

OWING to the climatic conditions in the tropics and the wealth of animal and vegetable life skin diseases are extremely prevalent. Bacteria, fungi, protozoa and immature insects find a congenial soil on the skin or in the cavities lined by mucous membrane. Simple inflammatory, pigmentary and other changes also occur.

Various forms of ringworm are especially common, whilst fungi may even invade the deeper tissues producing grave destruction. Deep and intractable ulcers are of frequent occurrence, being caused by bacteria, spirochaetes and protozoa. The well-known tropical ulcer is a characteristic example. Various insect larvae invade the skin and nasal cavities producing destruction of tissue, whilst the mature female jigger flea utilises the soft skin round the toes as a convenient spot for breeding.

In addition to these parasitic diseases, certain forms of cancer occur, though less commonly than in temperate climates, and also very striking anomalies of pigmentation.

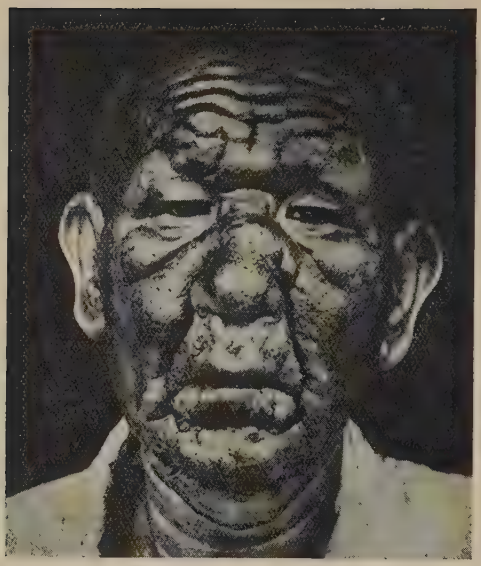
Owing to the heightened activity of the skin of Europeans residing in the tropics, it appears to become more sensitive to physical and chemical stimuli. This is well seen in sunburn and prickly heat.

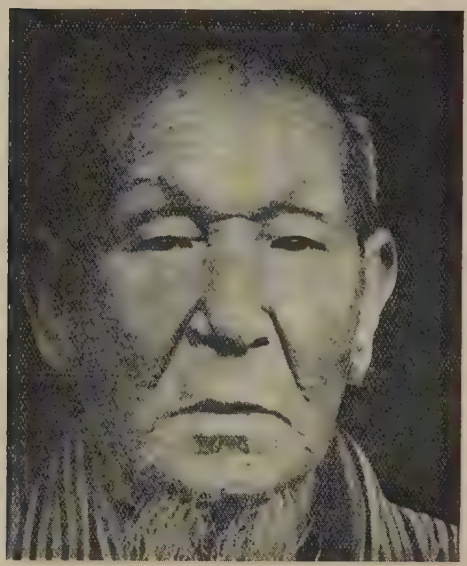
The juices or hairs of various plants may also give rise to irritation and inflammation.

Treatment varies with the nature and cause of the disease ; a correct appreciation of the primary cause being essential for effective treatment.

Prevention depends upon the avoidance of infected persons and a strict adherence to all rules of personal hygiene.

The gravity of many skin diseases is much increased by the liability to secondary infection by pus-forming organisms ; it is, therefore, necessary to emphasise the importance of early treatment and, above all, of strict cleanliness. Many exhibits in this Section are of special interest. An excellent specimen is shown of a curious condition, known as " mossy foot," from South America ; the cause of this striking disease has not yet been ascertained. Specimens are exhibited showing the deep penetration of pathogenic fungi in the condition known as mycetoma ; whilst the invasion of the human body by the larvae of flies is a matter of considerable interest, and is well shown in certain exhibits, more especially in that of an Indian's skull thus affected. In this connection also attention is called to the specimens of chigger flea, the female of which invades the human skin and causes considerable local trouble. Natives are very skilled in extracting these pests and a crude model in clay, made by a native of Tanganyika Territory, shows the process being carried out. Illustrations show curious anomalies of pigmentation and attention is directed to the photograph of a giant native of Central Africa, with his black wife and albino baby. Another medical curiosity is the condition known as " ainhum," of which specimens are shown ; in this disease a constriction appears round a digit, generally the little toe, and gradually a process of spontaneous amputation takes place.





LEPROSY.—The result of modern treatment.
From Japanese Government Asylum, Tokio.

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LEPROSY.

LEPROSY is a chronic, non-hereditary, communicable disease caused by a bacillus. It affects chiefly the skin, the mucous membranes and the nerves, leading to the formation of disfiguring nodules, festering sores and gross deformities. Though not confined to the tropics, it is very common in hot climates where it constitutes a serious social and economic problem. Infection probably takes place through skin abrasions—possibly due to biting insects —and is specially liable to occur where heat is combined with moisture.

Two forms of leprosy are recognised, the nodular and the anæsthetic. Nodules, ulcers, contractures, loss of fingers, and other deformities are produced. The eyes are frequently affected and blindness may occur.

A definite cure has not been discovered, but certain products of chaulmoogra oil produce beneficial results.

To prevent the spread of this disease lepers should be segregated in colonies, which must be attractive to the inmates. Lepers should not handle food supplies, sell in the street, beg, or have association with children.

General rules with regard to housing and sanitation are of great value.

From the earliest times leprosy has stood for all that is most repulsive in disease. The paintings and photographs shown in this Section illustrate the deformities, mutilations and disfigurements incidental to its progress, and explain the drastic measures which have been taken for its suppression. Up to the present time segregation has been the chief measure of prevention, even uneducated natives have been known to expel from the community or even kill, those affected. The illuminated statistical schemes show that, in a measure, these efforts have been crowned with success, but only where the disease is sufficiently limited for this to be practical. Treatment is, however, the key to prevention, and it is upon the attraction of a successful method of treatment that a comprehensive prophylactic scheme must be based. Treatment by chaulmoogra oil has been employed for many years, but recently the introduction of certain soluble products of the oil -sodium gynocardate, the ethyl esters, &c. —has led to a definite advance, and there is reason to hope that a cure for this disease has been found.

Leprosy was at one time common in England, as is testified by the leper windows in many ancient churches ; amongst the exhibits are certain models which bear eloquent testimony to this historical aspect and should emphasize the humanitarian and imperial side of leprosy. There are more known lepers in the British Empire than under any other flag.

The British Empire Leprosy Relief Association has been formed to extend and co-ordinate the fight against this loathsome and mutilating disease, which spares no class or race.

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SUNSTROKE.

THIS term includes two conditions both due to overheating of the body, generally in a moist atmosphere. The immediate cause may be either direct exposure to the sun's rays or prolonged exposure to a high temperature.

(1) "Heat syncope" is a condition of collapse and insensibility, with cold skin and feeble pulse. Though alarming it is rarely fatal, and should be treated on the same lines as syncope from any other cause.

(2) "Heat stroke" is characterised by apoplectic symptoms, insensibility with stertorous breathing and high temperature. It has been thought that possibly infection with some organism is responsible for this condition, but there is little support for such a theory, and it is probable that heat and actinic rays are directly operative. There is no doubt that physical exhaustion, over-eating and alcoholic indulgence, predispose to "heat stroke." Excessive temperature even up to 110°F. frequently occurs and a fatal result is common.

Treatment resolves itself into reducing the temperature as quickly as possible—by cold baths, ice, fans, &c.—in the meanwhile preventing respiratory or circulatory failure. Artificial respiration and bleeding may be useful, whilst concomitant malaria must receive prompt treatment with quinine.

Prevention depends upon temperance in all things; suitable clothing, proper protection of the head and back from the sun, ventilation of rooms and good buildings.

Special attention is directed to the exhibit emphasizing the need for eye protection and glass suitable for this purpose. Exhibits show the means adopted to protect the head and spine by helmets, spine pads, and other contrivances, whilst a small model of a double-roofed tent illustrates a more general method of protection. In Mesopotamia emergency measures for treatment of heat-stroke were required and improvised bath houses, of which a rough model is shown, were utilized with success.

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SPRUE.

SPRUE is a disease found in many tropical countries. It is chiefly confined to Europeans, and is the cause of much invaliding. The main characteristics are frequent and copious diarrhœa, sore tongue, anæmia, and a great tendency to relapse.

The causation of this disease has not been definitely ascertained. Some think it is due to fungi invading the food tract, others think it is bacterial in origin. Dietetic deficiency has been suggested, whilst some observers state that it is caused by a defect in the internal secretions of the body.

The disease comes on gradually, and eventually leads to anæmia and progressive wasting.

Drug treatment has not proved to be very effective, though yellow santonin and powdered cuttle-fish bone are said to have done good. Careful dieting is of the greatest value ; a pure milk diet is good but must be persisted in, whilst certain fruits—strawberries and bael fruit—are of benefit, and may be combined with the milk diet. A new form of treatment with extracts of certain internal glands has been advocated ; the results have been highly promising, but further trial is necessary.

Until the cause is known no rules for prevention can be laid down. Once the disease is recognised the patient should be sent home to a cool country and, with rare exceptions, should not be allowed to return to districts where sprue occurs.

Sprue is a mysterious disease, the cause of which has not been definitely determined. Illustrations are shown of the fungus which has been said to be the causal agent. Recently Scott has attributed the disease to defective action of certain internal glands leading to a deficiency of calcium salts in the blood. This theory has suggested a remedy, and the drugs used in the treatment—parathyroid gland and calcium lactate—are shown. The serious nature of the complaint can be easily grasped from a glance at the specimen of affected intestine which is exhibited. The bowel is thinned to such an extent that it is obvious that all its absorbing surface is destroyed, and digestion must be seriously impaired.

In the past treatment has been mainly dietetic, and examples are shown of some of the fruits which have proved of value. Milk has always been a favourite article of diet in the treatment of sprue.

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UNDULANT FEVER

(MALTA FEVER.)

A PROLONGED fever caused by infection with minute organism—the *Micrococcus melitensis*—and transmitted to man in infected goats' milk and its products—cheese, cream, etc.

The disease is common in the Mediterranean, more especially at Malta, but also occurs throughout the world in sub-tropical and occasionally tropical climates.

The fever is very protracted, lasting from three months to two years. It may be mistaken for typhoid fever, rheumatism and phthisis, but can be distinguished by laboratory methods. During the Crimean War it was a serious scourge amongst the naval and military forces for, though the mortality is low, it causes prolonged sickness.

Wherever infected herds of goats are found and their milk is used without being sterilized, the fever is common. The Maltese goat is often infected without appearing in any way ill.

The bacillus, which infects man through his food, multiplies and is found in most of the internal organs, being eliminated in the urine and fæces.

The organism is closely allied to one which causes abortion in certain animals.

Treatment consists of careful nursing and the use of appropriate vaccines.

Prevention depends upon the avoidance of unsterilized goats' milk and its products ; the sterilization of infected articles and a proper system of conservancy.

There is no better example of the direct result of scientific preventive measures than undulant Fever. This is well shown in the two illuminated statistical devices. The discovery of the source of infection—goats' milk—and the prohibition of its use for human food, unless boiled, put an end to a danger which had constantly threatened our soldiers and sailors in certain parts of the Mediterranean and elsewhere. A glance at the temperature charts and at the photograph showing the disastrous result of such a prolonged fever will carry conviction of the benefit conferred upon humanity by those who discovered the parasite and its mode of transmission. The ortol test for boiled milk is of considerable interest.

Specimens of Maltese goats are shown and small models of various domestic animals which also may be infected.

TROPICAL HYGIENE SECTION.

THE central exhibit depicts a small portion of an Assam tea garden, with properly designed houses for European Manager and Assistant, and for native labour on the Estate.

The Manager's bungalow is of the Burmese type of house. It is arranged on two floors, the lower one, consisting of a single room and pantry, is made of very stout brick work, whilst the upper storey is made of wood or bamboo matting. The lower room is used as a dining-room.

The upper storey comprises a very large verandah, which, it will be observed, is carefully screened with mosquito gauze, and five rooms arranged in the form of a cross. This gives the maximum amount of outside wall and catches every breath of wind that blows. The roof may be either of thatch (made of palm leaves), corrugated iron or tiles.

A house of this kind is very cool and, provided it is properly screened to keep out mosquitoes, should be healthy in almost any country, however malarious.

The smaller house for the Assistant resembles the larger one to some extent, but is rather simpler and cheaper in design. Again it will be observed that the windows and verandah are screened.

The two long buildings are used as coolie lines for the labourers. It will be observed that they are elevated above the ground, the plinths on which stands are made being either of concrete or brick on edge. The latrines are situated at the back of the building and are connected to the main block by a masonry path, which is to prevent the spread of hookworm disease. Water for the employees is from a piped supply.

The banks of the stream which runs through the garden are riveted with brick on edge to prevent mosquito breeding ; further arrangements are made for oil to drip from a barrel into the water to assist in making the stream unattractive.

TOWN PLANNING AND HOUSING.

Those who have ever visited an ancient Oriental city and are familiar with the term " bazaar " will recognize

that Town Planning presents an even greater problem in Eastern countries than it does in our own land.

In this Section will be found an exact scale model of an overcrowded bazaar in Bombay City and beside it another model showing how the conditions were remedied. Various types of residences—for Europeans, native clerks and Government employees—are displayed. These have been erected in the new City of Delhi.

Types of houses and coolie lines will also be found in the main central exhibit of the Assam tea garden.

The pictures show town-planning schemes as proposed in many Oriental towns. These are full of interest and should receive careful study.

PILGRIMAGES.

People throughout all the ages have gone on pilgrimages to certain holy places and shrines as a matter of religious duty ; Chaucer's Canterbury Tales gives the best picture of the same events in our own country. In many hot countries the inhabitants are very devout, a pilgrimage forms part of their religion. The particular object may be a shrine, the tomb of a great saint, a holy well or lake, or the confluence of two great rivers. Regular recurring religious festivals, somewhat akin to Easter and Christmas in our land, also occur. These ceremonies not infrequently bring together vast crowds of worshippers. Many come on foot for hundreds of miles bringing presents with them. It is obvious that if sanitary arrangements are not made on a large scale, well in advance (and often including thousands of miles of roads), these festivals may be the cause of terrible outbreaks of disease and may be the centres from which devastating epidemics start. The pictures give some idea of these gatherings and the sanitary arrangements necessary to deal with the situation.

MARINE QUARANTINE.

From the very earliest times ships, ship-borne passengers and merchandise have been a potent factor in spreading disease. Consequently in all civilized countries a system of inspection and disinfection of infected material and quarantining sufferers from certain maladies has become necessary if disease is to be kept out.

In many countries where pilgrimages to holy places take place very elaborate arrangements are necessary ; these consist of detention camps, hospitals, disinfecting stations, special railways, steamers and landing stages. Some of the more interesting of these are illustrated in this Section. Some models of Port Health Officers' boats are shown

especially prepared for isolating a patient from the local mosquitoes, as is necessary in yellow fever cases.

VACCINATION.

Vaccination as a protection against smallpox was discovered by Jenner in 1796. It is an essential precautionary measure for countries in all parts of the world. In many parts of the Empire there are territories on the borders over which we have no control, and which not infrequently suffer from virulent outbreaks of the disease ; the infection is often carried into British Territory by traders and travellers.

In this Section is shown the method of preparing the vaccine lymph from calves. For many reasons it is a much more troublesome matter in hot countries than in colder ones. Dr. Allen Green's apparatus for purifying the lymph with chloroform is also displayed and the results that are obtained by the use of it.

Pictures of the lymph preparation depôts in many parts of the Empire will be found on the walls.

THE FOLLOWING WILL BE FOUND IN THE ANNEXE :

ORIENTAL SANITARY APPLIANCES.

It is common knowledge that many races in the Orient do not approve of the sanitary fittings as usually found in European houses, and, being intensely conservative in their mode of living, refuse to use them.

For these races English manufacturers have designed special fittings. Two of these, namely, Messrs. Doulton, of Lambeth, and Messrs. Shanks of Bond Street, London, have kindly lent models of such necessary articles as closets, urinals, shower baths, &c., particularly designed for the needs of India, China and the Far East. These have been installed in many private houses, hospitals, schools and public conveniences in these lands, and are deservedly popular. They are very much superior from a sanitary point of view to anything which can be manufactured in the countries themselves.

CHLORINATION OF WATER.

Chlorination of water as a method of rendering it free from disease spreading bacteria is becoming of the greatest importance to all sanitarians and engineers. The process is usually carried out in one of two ways—(1) by adding to the supply a solution of known strength made by mixing

chlorinated lime and water—this is used in the Army for troops in camp and for emergency measures ; (2) by adding pure chlorine gas obtained from cylinders direct to the supply.

Various ingenious pieces of apparatus are displayed for adding the chlorinous liquid.

Two varieties of chloronomes for adding the gaseous chlorine can also be seen working. In both the correct amount of gas is added as the water flows through a pipe or channel ; the quantity can be easily regulated.

Models are lent by the Paterson Engineering Co., of Kingsway, London.

MECHANICAL FILTERS.

Mechanical filters or rapid filters as they are frequently called are pieces of apparatus especially designed to purify water with the smallest possible amount of sand. The slow sand filter gives about two gallons per square foot of sand surface per hour—mechanical filters will give 50 to 100 gallons for the same surface and can be made to give even more.

The two essentials for success are a layer of suitable sand about 2 ft. 6 in. in thickness and the addition of alum to the water in correct quantities so that a sticky film is added on the top of the sand which greatly increases its efficiency. As the filters become dirty, the sand blocks up ; it is then washed by reversing the flow and stirring up the sand.

Two varieties of filters are shown, those lent by the Paterson Engineering Co., of Kingsway, London, and the Candy Filter Co., of Westminster. Both makers show models of the filters, their control gear, and also various interesting devices for adding alum solution, lime and sterilising fluids, such as liquor of chlorinated lime.

These filters are particularly useful in small water schemes for villages, tea and rubber estates, &c., in hot countries.

ACTIVATED SLUDGE.

The Activated Sludge method of purifying sewage was discovered by Dr. Gilbert Fowler and Dr. Ardem in 1912. The process consists of two parts (1) making or " activating " a sludge, and (2) mingling this material in suitable proportions with screened crude sewage in presence of oxygen. The first part was originally carried out by blowing air for some weeks continuously through a small quantity of sewage ; slowly a change took place in the sludge till

eventually a light, very active material was obtained, which on examination was found to consist largely of protozoa and bacteria.

The results obtained by carrying out the second part of the process are very remarkable and consist in a precipitation of the colloidal organic matter in the sewage and a nitrification of the dissolved nitrogenous material. The models show three distinct methods of applying the process:

(1) Loaned by the Activated Sludge Co., of Westminster, makes use of compressed air for stirring and lifting purposes.

(2) Loaned by Ames Crosta Co., of Nottingham, makes use of a mechanical propeller which keeps the sludge in motion in the tank, and by breaking the surface of the liquid sewage allows absorption of oxygen from the air.

(3) The "Sheffield" method in which the stirring is done by a series of paddlewheels.

DISINFECTION.

Disinfection of clothes, bedding, merchandise, rooms in houses, holds of ships, &c., is well known to be necessary if the spread of communicable diseases is to be prevented. Besides these must now be added, as equally important, the killing of fleas and lice in clothes, rats, mice, cockroaches, ants in ships and bugs in bedding and houses. Both the germ of disease, as in smallpox, and the insect carrying the disease, as the rat-flea in plague, must be killed. Hence, many ingenious pieces of apparatus have been devised for the killing of bacteria or pests. Several will be seen here:

(1) Clayton's disinfector (lent by Messrs. Clayton, of London). This generates sulphur di-oxide and carbon monoxide and is especially suitable for ships' holds for killing rats and cockroaches.

(2) Lieut.-Colonel Liston's apparatus manufactures hydrocyanic acid gas, which is very deadly for all insects, rats, and vermin in clothes, and can be used for ships, grain stores and rat-infested warehouses.

(3) Steam disinfector (lent by Messrs. Manlove, Alliot & Co., Nottingham and London) uses current steam and is suitable for ridding clothes, bedding, &c., of the germs of diseases like scarlet fever, cholera, &c.

(4) A portable sack steam disinfector, designed by Lieut.-Colonel Lelean, R.A.M.C., which is suitable both for disease germs and vermin in clothes, is so light and small that it can be carried on a bicycle.

CLAYTON DISINFECTING MACHINE.

The Clayton machine produces "Clayton Gas," a mixture of sulphur-dioxide and sulphur-trioxide, which is both visible and pungent. This gas has definite bactericidal, insecticidal and rat-killing properties.

By the Clayton Process the air in the compartment undergoing fumigation is extracted, and as it is drawn through the machine becomes converted into sulphur-dioxide and sulphur-trioxide at a high temperature by passing over burning sulphur in a specially-constructed generator. The gas is cooled and forced back into the compartment. Delivery and suction operations, which are produced by a powerful blower, proceed simultaneously.

Gas strength control is maintained throughout the operation. The gas test, a simple one, is based on the fact that sulphur-dioxide is very soluble in water. It consists of filling the body of a burette with gas (from the generator or compartment, as required) admitting water, and, after agitation, noting the amount of water drawn in. This equals the volume of sulphur-dioxide absorbed, and as the burette is graduated in hundredths, it can be read off directly as a percentage.

PLANT DISEASES SECTION.

PLANTS, in common with other organisms, are subject to disease. The diseases which attack plants are caused by much the same agencies as those affecting man, but especially by Bacteria, Insects and Fungi. These bring about enormous destruction of crops and lead to scarcity and hardship. The Irish potato famine caused by potato blight in the forties of the last century, the ruin of the Ceylon coffee industry some years later by the coffee leaf disease and the immense loss due to the Cotton Boll weevil estimated at £40,000,000 annually, are but a few examples chosen from many.

The injury to human welfare caused by diseases of staple food and other crops, especially in the tropics, is so great as to be almost beyond calculation. The amount of suffering which results from the failure of crops in certain areas can scarcely be realised by those living in countries like England, which can rapidly replenish their needs by importation from all parts of the world.

The fight against these diseases in the tropical parts of the British Empire commenced only comparatively recently, and most of the progress has been achieved in the present century. Practically every part of the Empire now maintains a trained staff of Entomologists and Mycologists engaged in studying plant pests and diseases and in working out and applying preventive measures. New diseases are continually appearing and new methods of combatting them have to be found.

DISEASES DUE TO BACTERIA.

Bacteria do not cause as much damage to plants as do insects or fungi. There are, however, several which can make the growing of particular crops unprofitable. One of these, Citrus canker, is exhibited. This disease has long been prevalent in India and the Far East and was introduced from Japan into the U.S.A. and South Africa some eighteen years ago. Here, the damage which resulted from its introduction was so severe that both countries decided

on a rigorous campaign of extermination, the results of which are within sight of complete success.

DISEASES DUE TO FUNGI.

Much destruction is brought about by fungi. These are vegetable organisms and include such diverse forms as mushrooms and the moulds which grow on decaying matter. They consist essentially of thin threads which are single or woven together in various ways. They are propagated chiefly by small seed-like bodies called spores. It is owing to the fact that fungi do not contain leaf-green (chlorophyll) —which enables an ordinary plant to build up its own starch and other organic substances—that they are forced to obtain their nutriment from organic matter, living or dead. Those attacking plants usually penetrate into the tissues of leaf, stem or root, and there use up the food which normally goes to nourish the plant, or kill the living plant substance by means of poisonous excretions. Models are exhibited showing the structure of some of these fungi, the manner in which their spores are formed and the method of entry into the leaf.

Amongst the most destructive parasitic fungi are the smuts which attack cereals. The United States could have doubled their supply of oats to the Allies in 1917 had it not been for oat smut, while in the same year twice as much Indian corn was lost from maize smut as was sent overseas. Sorghum, one of the staple food grains of the tropics, is particularly prone to these diseases, which, in India, cause an annual loss of some £2,000,000. The specimens exhibited show how the grain is replaced by masses of black spores. These contaminate healthy grain used for seed and as the seeds germinate fungal threads enter into the tissue of the seedling, giving no external signs of their presence.

The most destructive of these diseases can be completely prevented at a trifling cost by soaking the seed in certain chemicals before sowing. Various other smut diseases are also shown, as well as a number of different fungus diseases of food grains. The United States lost 400,000,000 bushels of grain in 1917 and Canada 100,000,000 bushels in 1916 from fungi of one sort or another.

The number of fruit diseases caused by fungi is legion. Various examples on oranges, limes, bananas, papaw, coconuts, apples, &c., are illustrated amongst the exhibits. In some cases only the fruit is attacked, in others the leaves, stems or roots. Sometimes the damage takes place after the fruit is picked, especially when it has to be shipped over-

seas. Successful fruit growing often means successful control of these diseases, and in many parts of the Empire wonderful results have been obtained by spraying and other remedial measures.

The great tropical plantation crops, such as tea, coffee, cocoa, tobacco, sugar-cane, rubber and the like, all suffer heavily from fungal disease. The types of attack are too varied to be summarised, but certain of those that can be conveniently illustrated are shown. In the aggregate these diseases probably cause a greater monetary loss than any others, and the strenuous efforts in fighting them are meeting with a considerable measure of success.

DISEASES DUE TO INSECTS.

Cotton, one of the most important tropical crops, is especially susceptible to attacks from insect enemies ; the number of different insects that feed on cotton is considerable, but only seven of the most important species are exhibited. The notorious boll weevil has fortunately not yet secured a footing within the British Empire, but the pink bollworm occurs in several areas, and is so destructive that in Egypt alone the losses attributed to it in 1921 totalled £10,000,000.

Sugar-cane is also subject to much damage by many different insects, various kinds of chafers whose grubs attack the roots of the cane being particularly difficult to deal with. Many of these beetles are exhibited. One species was accidently brought into Mauritius from the West Indies, and soon became a serious pest, but its numbers have been much reduced recently, as a result of the introduction of some of its natural parasites. The coconut has of recent times been cultivated on an increasingly large scale in many tropical parts of the Empire, and several of the insects that attack the palm are shown. The large rhinoceros beetle and the red palm weevil bore into the trunks and very soon kill fully grown trees if left unchecked. Various caterpillars and small beetles also prevent development of the fruit by destroying the leaves.

The insect enemies of tea are numerous, and in many cases difficult to control, because of the undesirability of using the poisonous sprays commonly employed against leaf-eating insects. A selection of the more important pests is exhibited.

The extent to which valuable timber is destroyed or rendered useless by various wood-boring insects is even now very inadequately appreciated, and samples are therefore shown of various Indian timbers injured in this way.

Improved forestry methods are doing a little to check such destruction, but in most parts of the Empire there is no real attempt at control.

It is, however, probably in connection with stored foodstuffs, and especially cereals, that insects inflict the greatest financial loss on mankind. The damage done by grain pests amounts to many millions of pounds sterling every year, and this is all the more deplorable in that a large percentage of this loss might be prevented by the general adoption of better methods of handling and storage.